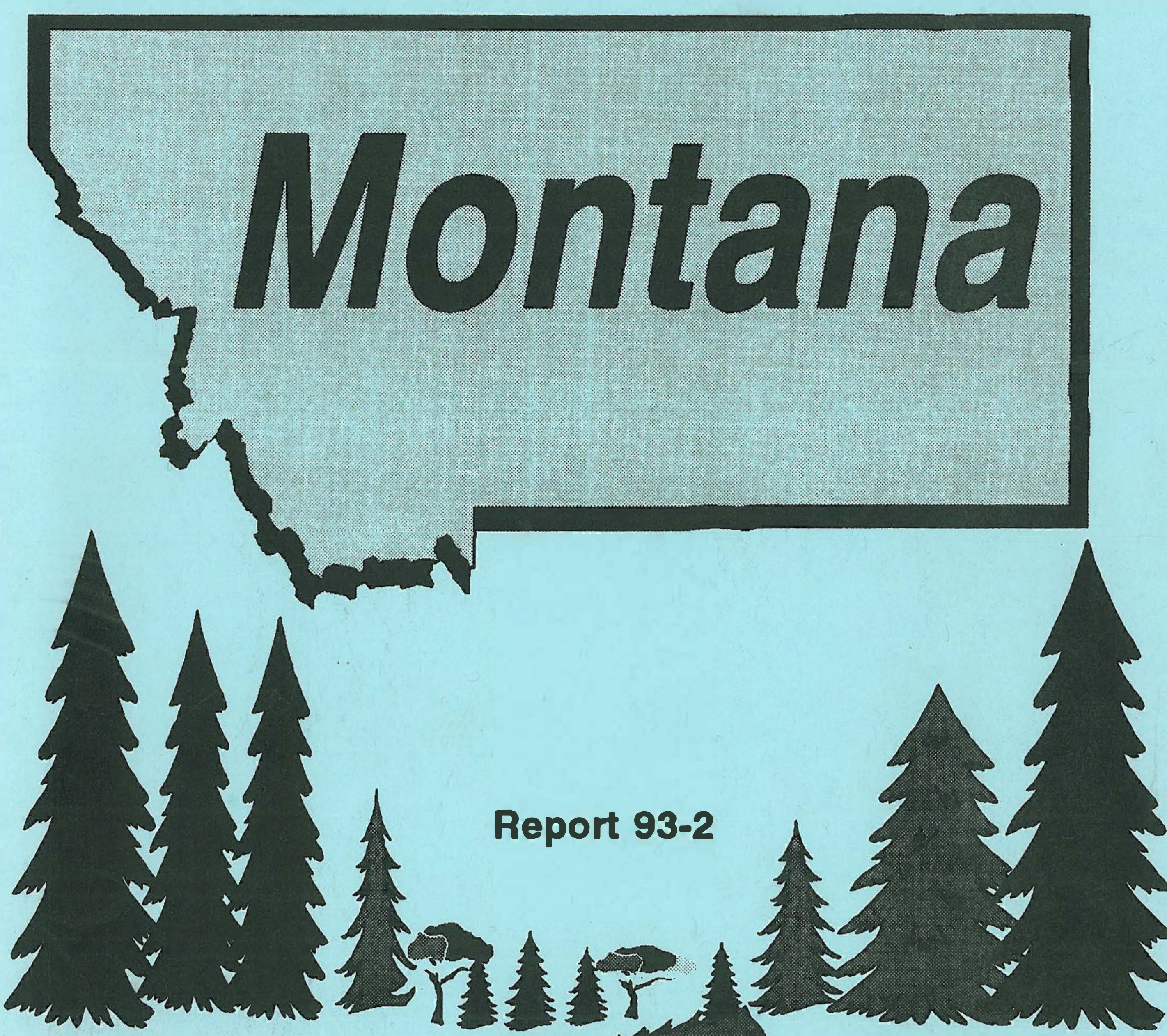
Forest Insect & Disease Conditions and Program Highlights 1992



Report 93-2

USDA Forest Service
Northern Region

Montana Department of State Lands
Forestry Division

MONTANA INSECT & DISEASE CONDITIONS AND PROGRAM HIGHLIGHTS

1992

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July 1993

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INTRODUCTION

This report summarizes the major insect and disease conditions in Montana during 1992, and was jointly prepared by Timber, Cooperative Forestry, and Pest Management, USDA Forest Service, Northern Region, and Montana Department of State Lands. Information for this report was derived from ground and aerial surveys conducted throughout the State, except national parks and most national forest wilderness areas.

SUMMARY OF CONDITIONS

Principal agents causing the most damage to forest trees in Montana in 1992 were root diseases, dwarf mistletoes, mountain pine beetle and western spruce budworm.

The number of acres infested by mountain pine beetle continued to decline to the lowest levels since 1967. Infestations occurred in 1992 on 66,051 acres, again primarily in lodgepole pine. Western spruce budworm-caused defoliation decreased in 1992 to 941,320, the second lowest level since 1950.

Montana, along with most western states, saw a large increase in subalpine fir mortality at the higher elevations. Western balsam bark beetle contributed to much of this mortality along with drought, stand age and root diseases. Mortality caused by pine engraver beetle (Ips) to lodgepole pine increased from 5,658 acres in 1991 to 30,668 acres in 1992, spurred by continued drought and the 1988 fires. Douglas-fir beetle infestations continue to cause mortality at levels slightly higher than in 1991.

Western pine beetle, fir engraver beetle and spruce beetle infestations continued at low levels in 1992. Douglas-fir tussock moth trap catches were below last year's low levels. No defoliation was detected.

One male gypsy moth was caught near Chester. Visible sawfly defoliation occurred on almost 2,000 acres of ponderosa pine on the Ashland Ranger District (RD), Custer National Forest (NF).

Incidence of root diseases remains high throughout the Region, though most mortality occurs west of the Continental Divide. Past management practices, such as selective harvesting and fire suppression, have increased the proportion of root disease-susceptible species in a number of habitat types around the Region.

Annosus root disease continues to be very damaging in ponderosa pine stands in western Montana, and has been especially prevalent in areas where trees have been selectively harvested. It has also been found causing mortality in Douglas-fir and may be the causal agent in the increasingly common sub-alpine fir mortality. Schweinitzii butt rot continues to be common on Douglas-fir throughout its range. Armillaria root disease also continued to be very damaging in many stands, especially those with large proportions of Douglas-fir and true firs.

Dwarf mistletoes still persist on about 2.5 million acres, resulting in an annual growth loss of approximately 33 million cubic feet. The species most affected by dwarf mistletoes in Montana are lodgepole pine, Douglas-fir, and western larch.

Diplodia blight continued to cause increasing damage and mortality on ponderosa pine. Elytroderma needle cast has been chronic for the past few years in the Bitterroot Valley, the Flathead Indian Reservation and around Flathead Lake. Lodgepole pine needle cast was widespread, but severe only in localized areas. Larch needle cast and needle blight were still present across the range of western larch. Damage from these two diseases was generally lower than in years past, but was still severe in localized areas.

White pine blister rust has persisted throughout the range of western white pine and whitebark pine, and has prevented the management of wild-type western white pine on moderate to high-hazard sites. It also continues to cause extensive mortality in whitebark pine stands, as well as limiting the production of cones.

Damage and mortality from Dutch elm disease continued, although it may be declining with declining numbers of live elms. Beetle trapping done a few years ago by Montana Department of State Lands indicated the vector for Dutch elm disease is widespread throughout the State, so mortality from this disease is likely to continue.

THE ANNUAL AERIAL SURVEY

The annual aerial survey was again conducted across the State by USDA Forest Service, Forest Pest Management personnel, for the purpose of monitoring Forest Health, by observing and mapping effects of insect and disease on forest landscapes. Most of the data summarized in this report was taken directly from annual aerial survey maps. The 1992 survey covered most forested Montana lands in 155 hours of flight time using two single-engine, fixed-wing aircraft under contract with Minuteman Aviation in Missoula. Areas not surveyed in 1992 include: Rocky Mountain RD, Lewis and Clark NF; Sioux RD, Custer NF; Pryor Mountains area, Custer NF; Crow and Northern Cheyenne Indian Reservations (IRs); Judith Mountain areas; Glacier and Yellowstone National Parks; and most national forest wilderness areas. All areas not surveyed in 1992 are scheduled to be flown in 1993, except the national parks, wilderness areas and the Rocky Mountain RD.

FOREST HEALTH IN ECOSYSTEM MANAGEMENT

The roles of tree pathogens and insects that feed on trees are being examined as part of an effort to characterize the health of ecosystems in the Northern Region. The first step has been to describe major functions of insects and pathogens in forest ecosytems. A list of major functions of some of the more notable pathogens and insects was developed for each of the ecosystem management (EM) climatic zones. Data from inventory subcompartments and aerial photography, combined with insect activity information from aerial survey maps, is being analyzed to complete a broadscale characterization of pathogen and insect aspects of forest health.

The objective of the analysis is to uncover long-term trends in ecosystem health as indicated by successional and disturbance patterns influenced by pathogens and insects. For example, where Douglas-fir and western larch regenerate after a stand-replacing fire, root diseases often play a major role in succession by shifting the survival advantage to western larch. The resulting stands often have much lower stocking densities and greater proportions of western larch compared to that which would be expected in the absence of root diseases. The functional role of root pathogens in this case is the selective reduction in Douglas-fir but the chain of events which are likely to follow, including altered fire functions, lead to long-term trends which are characteristic of these root-disease-influenced sites. The concurrent nutrient recycling function of the pathogens, probably also plays a role in allowing western larch to achieve fire resistance in relatively less time by taking advantage of nutrient availability. Understanding this sequence allows us to better determine what management actions are most appropriate to support healthy ecological trends.

Each of the functions has a characteristic range of amplitudes and periodicities on both spacial and temporal scales. The current distributions of pathogen and insect functions will be compared with probable pre-settlement distributions to identify some of the changes brought about by recent human activity. These will provide a basis for restoration plans.

Many, if not most, of the ecosystems we examine will be irreversibly altered by human activity. In most of these cases, we will need to understand the genetic and other functional implications to the extent that we can make reasonable "guesses" regarding sustainable conditions that are achievable and desirable. These will be our best understanding of healthy conditions for the systems in question. In the interim, we will be using a definition of forest health based on natural conditions: **Forest Health is typified by succession and disturbance functions occurring within the natural range of amplitudes and periodicities. They provide for a natural rate of nutrient and energy flows within forests.** This definition allows us to work with something more concrete than "sustainable ecosystems" until we have a better understanding of sustainability, particularly in altered systems.

INSECTS

Bark Beetles

Mountain pine beetle

Mountain pine beetle (MPB) populations continued a decade-long decline, having peaked in 1981 at nearly 2.5 million acres infested in the Northern Region alone. In 1991, approximately 163,000 acres were infested. Aerial survey estimates showed the total infested area decreased by half in 1992--to just less than 80,000 acres. In Montana, the infested area in 1991 totaled almost 149,000 acres. In 1992, that area declined to just over 66,000 acres. Aerial survey estimates generally total about three trees per acre per year killed. In many stands, however, beetle-caused mortality is much higher--often approaching 90 percent of the trees over 5 inches in diameter, over the course of an infestation.

The most active infestations in Montana remain on the Flathead National Forest (NF) where approximately 2,600 acres of western white pine type and another 4,200 acres of lodgepole pine type were infested--mostly on the Glacier View, Hungry Horse, and Swan Lake Ranger Districts (RDs); the Lolo NF where nearly 17,000 acres of LPP (Plains/Thompson Falls RD), and lesser amounts of other host species, harbor outbreak populations; and the Kootenai NF with more than 32,000 acres--most of which is still-infested LPP (on the Three Rivers, Rexford and Fisher River RDs). Smaller, scattered infestations in most host species are found on lands of other ownerships throughout the State. While many outbreaks are returning to nearly endemic conditions, there remains much LPP in many parts of western Montana that will become increasingly susceptible to the beetle in the next decade or two.

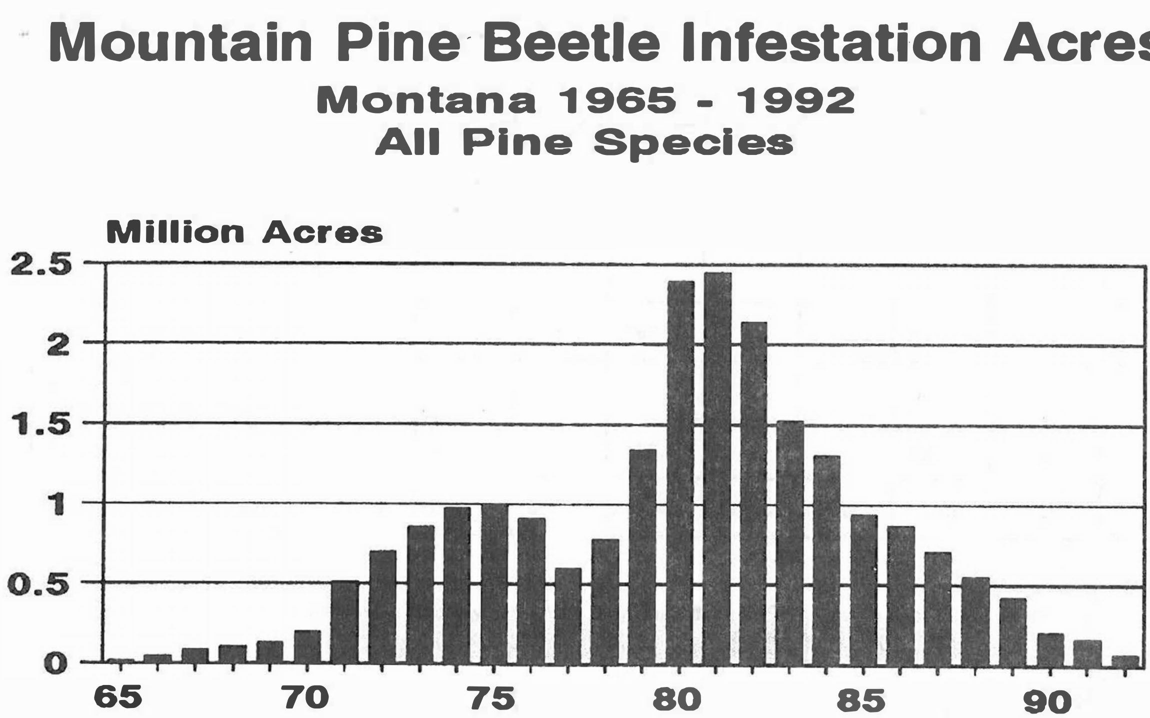


Figure 1--Mountain pine beetle infestation acres, all pine species, 1965-1992

Table 1.--Acres of mountain pine beetle-caused mortality on Federal and Indian Reservation lands in Montana from 1990 through 1992.

	-------- 1990 --------				-------- 1991 --------				-------- 1992 --------			
Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	41	-	2	-	489	-	-	-	2,041	6	138	-
Bitterroot NF	14	1,505	-	-	18	363	-	-	6	62	-	-
Custer NF	-	44	18	-	38	-	-	-	-	40	2	-
Deerlodge NF	852	-	2	-	960	2	-	-	168	-	-	-
Flathead NF	8,157	14	109	2,124	4,785	28	118	8,349	4,129	28	80	2,624
Gallatin NF	*	*	*	*	1,408	2	101	-	275	-	160	-
Helena NF	112	34	2	-	509	44	4	-	290	36	44	-
Kootenai NF	132,858	1,770	105	1,392	104,117	793	4	540	31,616	782	48	533
Lewis & Clark NF	8	810	-	-	-	42	-	-	212	153	149	-
Lolo NF	21,590	1,014	-	43	24,537	188	6	119	15,929	80	2	54
Total NF	**163,632**	**5,191**	**238**	**3,559**	**136,861**	**1,462**	**233**	**9,008**	**54,666**	**1,187**	**623**	**3,211**
Crow IR	-	216	-	-	-	44	-	-	*	*	*	*
Fort Belknap IR									76	129	-	-
Flathead IR	1,194	334	2	-	893	145	-	2	380	1,128	-	-
N. Cheyenne IR	-	-	-	-	-	40	-	-	*	*	*	*
Rocky Boy's IR	4	28	-	-	*	*	*	*	61	26	-	-
Total IR	**1,198**	**578**	**2**	**-**	**893**	**229**	**-**	**2**	**517**	**1,283**	**-**	**-**
BLM	22	46	2	-	141	14	2	13	299	20	54	4
Total (Non-FS)	**1,220**	**624**	**4**	**-**	**1,034**	**243**	**2**	**15**	**816**	**1,303**	**54**	**4**
Total	**164,852**	**5,815**	**242**	**3,559**	**137,895**	**1,705**	**235**	**9,023**	**55,482**	**2,490**	**677**	**3,215**

[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine
* Not flown.
[2]NF = National Forest

[3]IR = Indian Reservation

Table 2.--Acres of mountain pine beetle-caused mortality on State and private lands in Montana from 1990 through 1992.

	- - - - - - - - 1990 - - - - - - - -				- - - - - - - - 1991 - - - - - - - -				- - - - - - - - 1992 - - - - - - - -			
Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	11	-	-	-	16	-	-	-	127	-	2	-
Bitterroot NF	-	3,092	-	-	2	1,051	-	-	2	68	-	-
Custer NF	-	2	-	-	2	-	2	-		2	18	-
Deerlodge NF	152	-	-	-	304	-	-	-	88	2	-	-
Flathead NF	928	60	2	129	301	106	-	114	121	94	-	60
Gallatin NF	*	*	*	*	111	-	-	-	-	2	26	-
Helena NF	78	112	-	-	38	53	-	-	84	78	4	-
Kootenai NF	8,981	439	-	22	3,184	146	-	12	540	64	-	20
Lewis & Clark NF	23	78	-	-	-	51	-	-	8	24	45	-
Lolo NF	2,561	1,185	-	-	3,089	278	-	-	749	170	2	-
Stillwater SF	4,415	-	-	172	461	30	-	988	48	2	10	261
Swan River SF	8	2	-	50	22	-	-	204	2	-	-	26
Thompson River SF	1,004	115	-	-	366	38	-	-	279	70	-	-
Garnets	10	723	-	-	24	233	-	-	18	132	-	-
Total	**18,171**	**5,808**	**2**	**373**	**7,920**	**1,986**	**2**	**1,318**	**2,066**	**708**	**107**	**393**

[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine

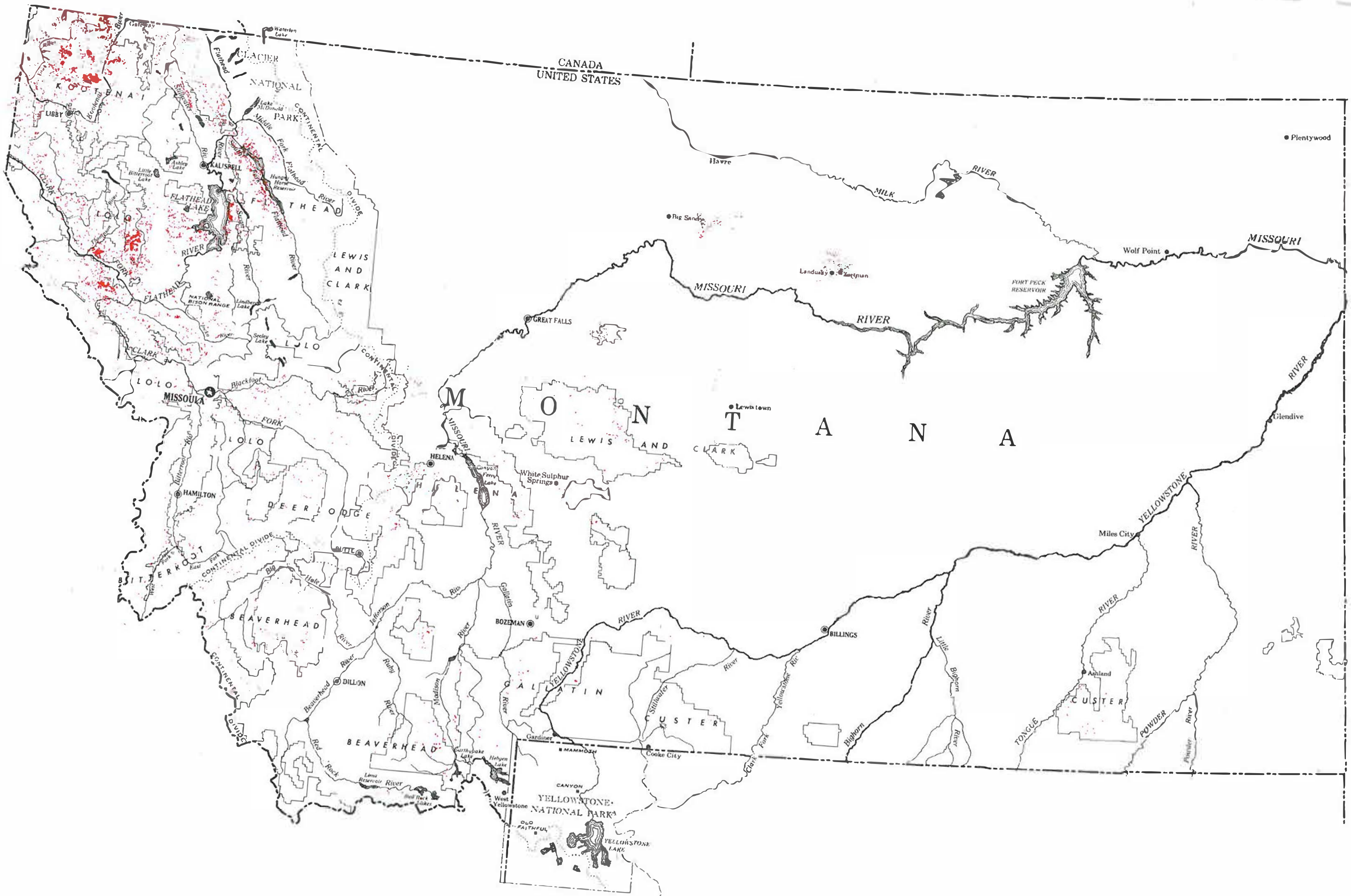


Figure 2--Areas of mountain pine beetle infestations in Montana, 1992.

Douglas-fir beetle

Outbreak populations of Douglas-fir beetle continued to plague areas on several Forests in Montana, where epidemics followed stand-disturbing factors such as windthrow, winter desiccation, fire, and drought effects. Total infested area in the State was 9,450 acres--up slightly from the more than 8,000 acres infested in 1991. Of that total, more than 4,500 acres were on the Gallatin NF, in the Mill Creek drainage (Livingston RD), where a serious outbreak exists. That epidemic, resulting from windthrow and fire, is being controlled through an active salvage program and the judicious use of pheromone tree baits. Other significant outbreaks are on the Beaverhead NF, where more than 1,100 acres are still infested on the Dillon and Madison RDs; the Helena NF, with nearly 1,000 infested acres on and surrounding the Lincoln RD; the Lolo NF with just over 600 acres infested, and the Kootenai and Flathead NFs, where approximately 500 acres are infested on each Forest. We estimate that in all these infestations, almost 13,000 Douglas-firs--representing approximately 4 MMBF volume--were killed in 1991 (1992 faders). Ground evaluations following aerial surveys showed still-active populations in some areas; however, in many, populations are declining as a result of more nearly normal amounts of precipitation.

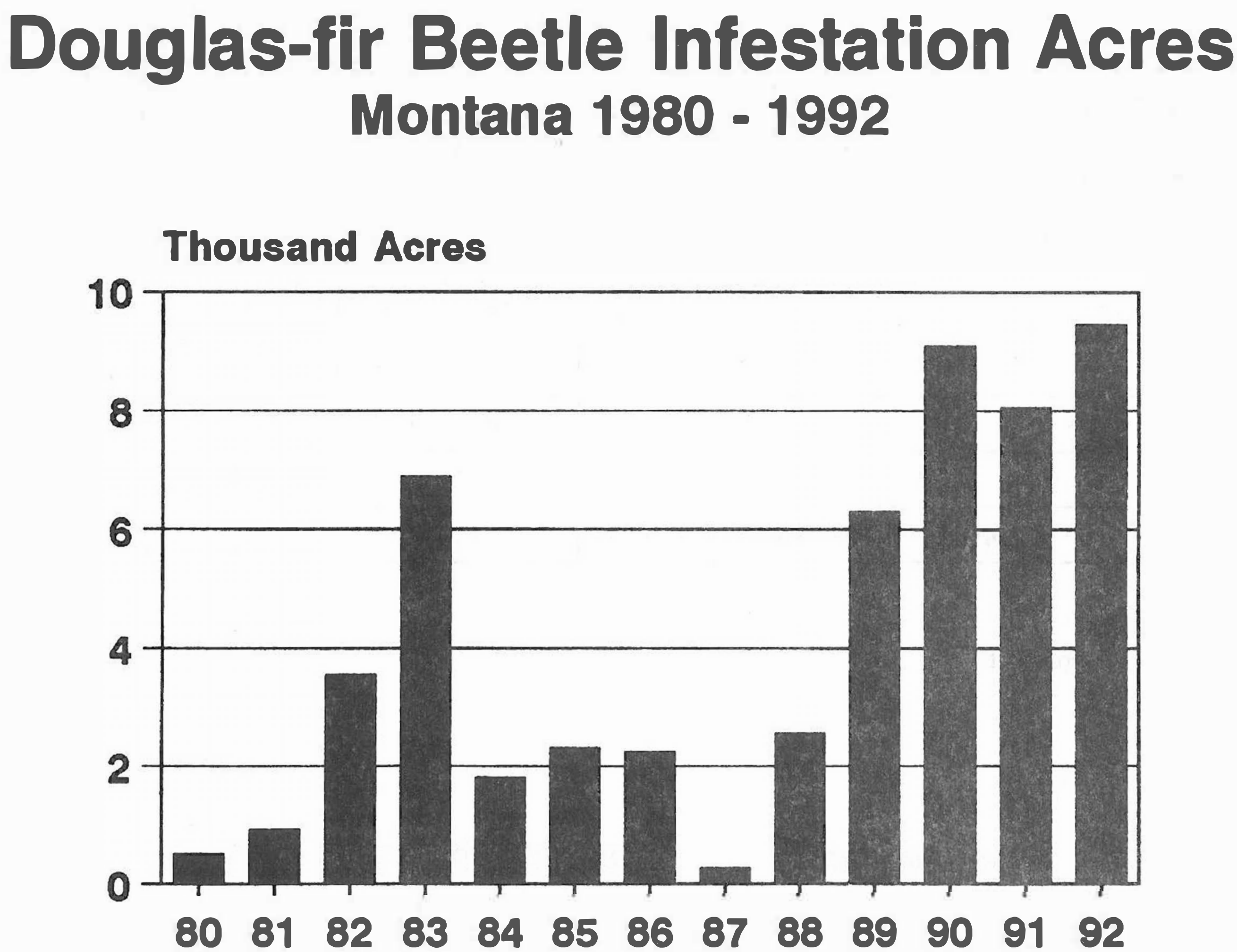


Figure 3--Douglas-fir beetle infestation acres in Montana, 1980-1992

Table 3--Douglas-fir beetle-infested acres in Montana, all ownerships, from 1990 through 1992.

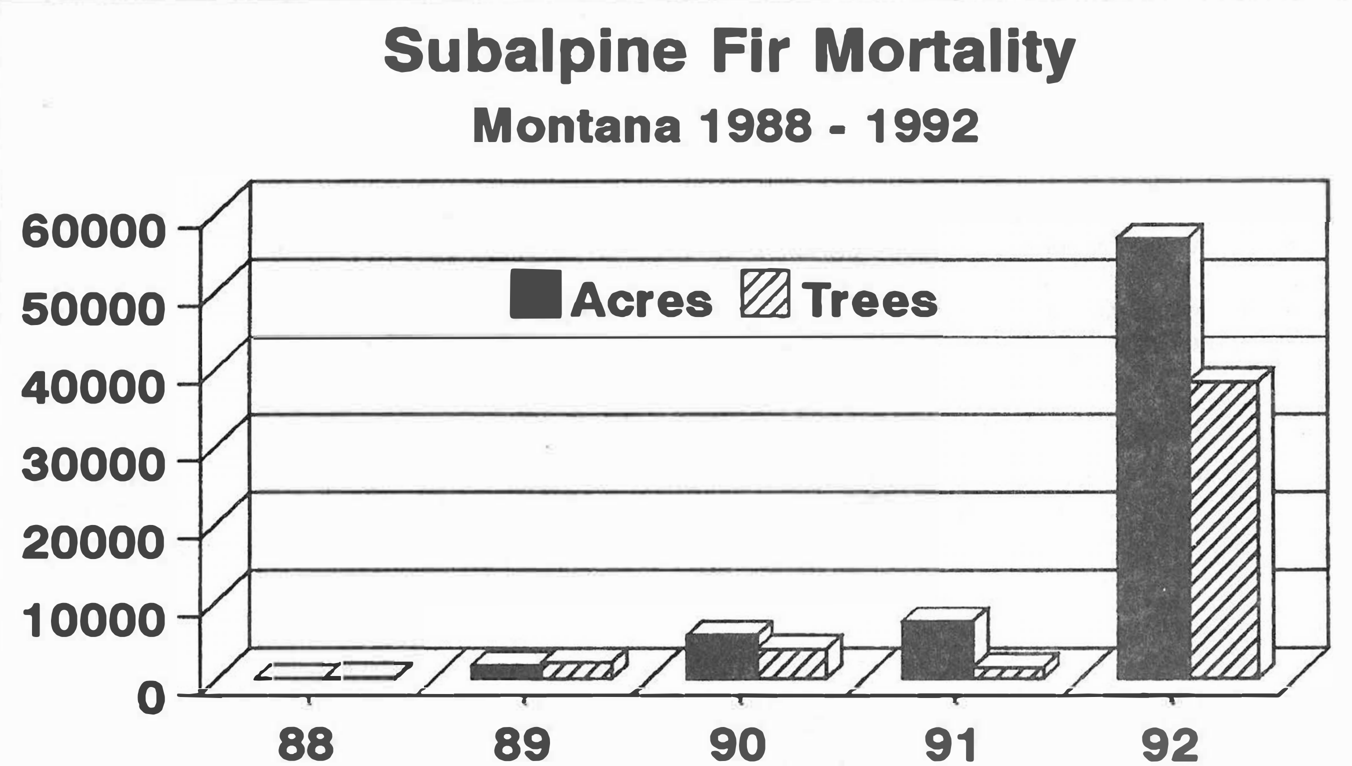
	------ 1990 ------			------ 1991 ------			------ 1992 ------		
Reporting Area	Acres	Trees	Vol. (MBF)[1]	Acres	Trees	Vol. (MBF)	Acres	Trees	Vol. (MBF)
Beaverhead NF	3,012	2,561	512.2	1,395	1,607	321.4	1,126	1,264	252.8
Bitterroot NF	2,769	2,920	876.0	1,770	2,947	884.1	219	511	153.3
Custer NF	4	9	1.8	2	20	4.0	100	226	45.2
Deerlodge NF	45	38	7.6	165	176	35.2	191	281	56.2
Flathead NF	194	302	90.6	770	774	232.2	570	701	210.3
Gallatin NF	*	*	*	1,183	1,210	242.0	4,572	4,355	871.0
Helena NF	12	18	3.6	35	114	22.8	928	2,377	475.4
Kootenai NF	1,240	991	297.3	472	616	184.8	486	505	151.5
Lewis & Clark NF	2	10	2.0	-	-	-	274	544	108.8
Lolo NF	1,546	1,446	433.8	1,775	2,475	742.5	685	1,397	419.1
Swan River SF	127	140	42.0	111	155	46.5	28	43	12.9
Thompson River SF	8	10	3.0	57	146	43.8	22	55	16.5
Flathead IR	117	225	67.5	80	153	45.9	80	257	77.1
Garnets	49	130	39.0	236	327	98.1	112	188	56.4
Other Areas							46	85	17.0
Total	**9,125**	**8,800**	**2,378.4**	**8,051**	**10,720**	**2,903.3**	**9,439**	**12,789**	**2923.5**

*Not flown.

[1](MBF) = 1,000 Board Feet

Western balsam bark beetle

Outbreak populations of the western balsam bark beetle expanded significantly throughout Montana in high-elevation subalpine fir stands. Whereas only 7,300 infested acres had been mapped in 1991, more than 56,500 acres--on which 38,000 dead trees were observed--were recorded in 1992. Most of the infested area occurs on the Gallatin and Beaverhead NFs, with 32,400 acres and 22,500 acres infested, respectively. Much of the Gallatin NF infestation is found on the Bozeman and Hebgen Lake RDs and adjacent lands of private ownership. On the Beaverhead NF, most infested stands are found in the Tobacco Root, Gravelly and Centennial Mountain ranges on the Sheridan and Madison RDs. Though not recorded on aerial survey maps, many infested stands were also observed on the Sula RD, Bitterroot NF. Ground surveys showed the western balsam bark beetle is indeed a major contributor to this mortality; however, there is a larger problem of drought, root disease, other secondary bark beetles, and overall stand decadence.



	88	89	90	91	92
Acres	21	1706	5500	7300	56571
Trees	105	2080	3759	1400	38080

Figure 4--Montana subalpine fir mortality 1988-1992

Western pine beetle

Western pine beetle populations in Montana were virtually unchanged in 1992 and remained at nearly endemic conditions. Only 850 acres--totaling just 600 trees--of western pine beetle-caused mortality were recorded this year, compared to just over 600 in 1991. No major outbreaks remain, but the largest concentrations were noted in PP stands on the Lolo and Bitterroot NFs and the Flathead IR in western Montana. Dry conditions are the major contributing factor in outbreaks of WPB. Increased moisture in affected stands has resulted in the ensuing population reductions over the past several years.

Pine engraver

The pine engraver, not usually an aggressive bark beetle--and therefore not known for long-lasting nor particularly devastating outbreaks--continued to kill trees in significant amounts in lodgepole pine stands on the Gallatin NF and in ponderosa pine stands on the Northern Cheyenne IR during 1992. Outbreaks on the Gallatin NF, resulting from trees weakened by fires in 1988 and the ensuing several years of near-drought conditions in southwest Montana, have expanded to more than 27,000 acres. Nearly 6,500 of those acres are on the Hebgen Lake RD--in stands adjacent to ones burned in and near Yellowstone National Park (NP). Another 6,900 acres are on the Bozeman RD--predominantly in the southern portion of the Gallatin Canyon. Almost 5,000 acres were recorded in the Boulder River drainage on the Big Timber RD. An additional 2,100 acres of beetle-killed lodgepole pine were recorded on the Beartooth RD of the Custer NF. Ground surveys suggest populations are declining--but beetles will continue to kill trees in those areas as long as drought-weakened trees remain. Though not all of the Northern Cheyenne IR was flown in 1992, outbreaks in PP stands there extend to several thousand acres. That outbreak has been exacerbated by nearly continuous slash creation and abnormally dry weather.

In 1992, we conducted a pilot project to test the effectiveness of the antiaggregant properties of the pheromones verbenone and ipsenol. In that initial test, we measured their effect against the aggregative pheromones of the engraver beetle--ipsdienol and lanierone. Preliminary results are very promising. Further testing may result in pheromone treatments which can effectively prevent slash from being infested by beetles until it is sufficiently dry to no longer provide suitable habitat for brood development. Should such treatments become operational, they could prevent many engraver beetle outbreaks.

Fir engraver beetle

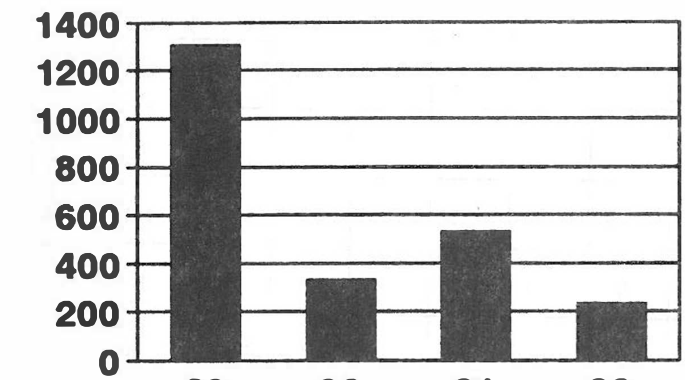
The fir engraver has never been a major problem in Montana--compared to northern Idaho--because of the relative scarcity of its primary host, grand fir. A total of 350 trees were noted as having been killed by fir engraver, on just over 230 acres, in 1992. We consider that to be nothing more than naturally occurring, endemic populations.

Spruce beetle

Spruce beetle populations are also found at only endemic levels in Montana at the present time. At times, spruce beetle outbreaks cause significant amounts of mortality in old-growth spruce stands following some type of disturbance. The most recent outbreak in Montana occurred in 1982-1984 on the Flathead and Kootenai NFs when more than 20,000 Engelmann spruce were killed on approximately 30,000 acres. In 1992, however, only 178 acres of spruce beetle-caused mortality (133 trees) were recorded. Most of that mortality, just over 100 acres (but only 23 trees), were noted on the Musselshell RD of the Lewis and Clark NF.

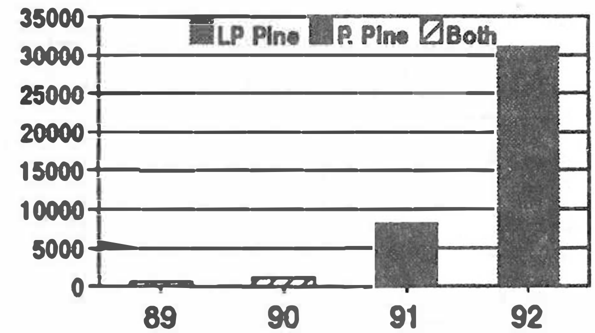
Other Bark Beetle Infestation Acres
All Ownerships in Montana
1989 - 1992

Fir Engraver Beetle



	89	90	91	92
Acres	1303	334	528	235

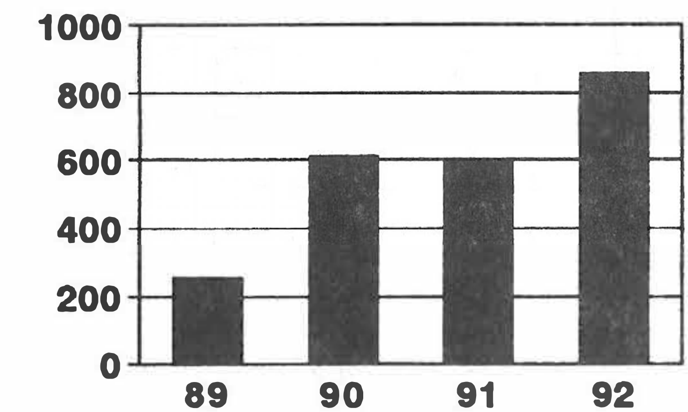
Pine Engraver Beetle (Ips)



	89	90	91	92
Both	544	1143	8097	30982
P. Pine	Not separated	Not separated	3039	315 *
LP Pine	Not separated	Not separated	5058	30667

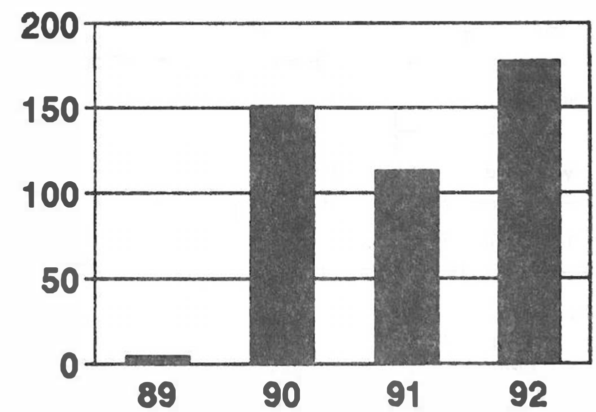
* Not all ponderosa pine stands infested by pine engraver beetle were flown in 1992.

Western Pine Beetle



	89	90	91	92
Acres	255	610	602	856

Engelmann Spruce Beetle



	89	90	91	92
Acres	5	151	113	178

Figure 5--Other bark beetle infestation trends, in Montana (all ownerships), 1988-1992

Table 4.--Bark beetle-infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana, all ownerships, 1990-1992.

	Engelmann Spruce Beetle			Pine Engraver Beetle			Western Pine Beetle			Fir Engraver Beetle			Western Balsam Bark Beetle **		
Reporting Area	1990	1991	1992	1990	1991	1992	1990	1991	1992	1990	1991	1992	1990	1991	1992
Beaverhead NF	0	0	7	0	376	0	4	0	6	2	23	0	5,260	3,463	22,543
Bitterroot NF	6	0	0	0	16	0	86	90	144	0	6	0	18	53	10
Custer NF	0	0	0	0	39	2,169	0	0	0	0	0	0	42	6	70
Deerlodge NF	0	55	2	0	1,895	0	0	4	2	0	20	0	33	534	242
Flathead NF	137	35	20	0	0	0	0	16	42	0	90	20	56	341	173
Gallatin NF	0	0	0	0	2,943	27,936	0	0	12	0	0	24	0	1,998	32,454
Helena NF	2	2	29	574	0	0	60	114	126	0	0	0	10	200	254
Kootenai NF	0	15	4	0	2	0	80	20	2	8	12	26	18	48	38
Lewis & Clark NF	4	0	109	43	1,402	871	0	0	76	0	0	96	4	106	553
Lolo NF	2	2	4	46	0	0	160	98	0	157	182	0	22	479	174
Garnets	0	0	0	0	0	0	90	26	50	0	0	0	8	12	27
Flathead IR	0	2	0	101	127	2	110	222	88	0	149	22	32	61	24
N. Cheyenne IR	0	0	*	379	1,295	*	0	0	*	0	0	*	0	0	*
Stillwater SF	0	4	0	0	0	0	0	0	0	0	6	0	2	0	10
Swan River SF	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Thompson R. SF	0	0	2	0	0	6	12	16	0	74	34	0	0	2	22

* Not flown

** Mortality in subalpine fir

Defoliators

Western spruce budworm

Number of acres defoliated by western spruce budworm decreased 59 percent, from 1,595,724 in 1991, to 941,320 in 1992. Number of acres and intensity of defoliation decreased substantially on the Bitterroot and Lolo NFs. Defoliated acres on the Helena NF has been steadily increasing since 1989. Defoliation on the Deerlodge and Lewis & Clark NFs has been relatively constant over the last 8 years (Figure 7).

Projects

Long-Term Impact Plots

Over the last 2 years, Forest Pest Management has installed long-term plots in historic budworm areas to meet the following objectives: (1) validation of the Prognosis-linked budworm damage model, (2) define impacts from budworm on ecosystem function and structure, (3) validation of aerial survey intensity ratings, (4) validation of the Carlson and Wulf Hazard Model, 1985; and (5) input into Regional broad-scale analysis. Plot selections were based on defoliation history, stand size, accessibility and the provision that further management would not occur for at least 10 years--preferably longer. Plots were established on the Bitterroot, Beaverhead, Lewis & Clark and Lolo NFs. During 1993, plots will be established on the Deerlodge and Helena NFs. Region One edit information is available on the plots currently established.

Pheromone Trapping Study

During 1992, we began an extended pheromone trapping study on the Bitterroot, Beaverhead, Lewis & Clark and Lolo NFs. The objective is to evaluate pheromone trapping as a predictor of defoliation for the coming year and of long-term population trends. Population data from traps might also be used to predict defoliation levels and initiate the Prognosis-linked budworm damage model. Trapping sites are located in close proximity to long-term plots. Results from the trapping study can also provide impact information for a much larger area and more reliability to our long-term plot assessments.

Evaluating Effects of Treatments on Budworm Populations and Defoliation

During 1991 and 1992, monitoring effects of various silvicultural treatments on budworm populations and defoliation was begun. Timber sales were selected on the Bitterroot, Beaverhead and Lewis & Clark NFs. Population and defoliation data were collected on partial-cut and on adjacent, uncut units. Total number of moths trapped across all harvested units was 39 versus a total of 80 moths caught in adjacent, uncut stands. However, average defoliation and average number of moths trapped across harvested units were not significantly different. This is probably due in part to the small sample size and averaging across all units regardless of the type of harvest. During 1993, the sample size will be increased by selecting additional sale units to monitor on the Deerlodge, Helena and Lolo NFs. Continued monitoring of previously selected sale units will also occur. Evaluation of budworm and other insect impacts on seed and cone production in Douglas-fir will be done in 1993.

Table 5--Acres of western spruce budworm defoliation visible from the air in Montana, 1990 through 1992.

	All Ownerships			1992 Acres by Ownership				
Reporting Area	1990	1991	1992	IR	NFS	BLM	State	Private
Beaverhead NF	60,064	26,725	39,914	---	19,500	13,689	2,527	4,198
Bitterroot NF	377,769	276,085	8,560	---	6,373	0	240	1,947
Custer NF	0	8,782	0	---	0	0	0	0
Deerlodge NF	298,881	356,065	282,067	---	120,705	61,133	23,317	76,912
Flathead IR	80	55	67	67	---	---	---	---
Gallatin NF	---	30,932	6,321	---	2,235	0	0	4,086
Garnets	321,891	165,828	14,514	---	---	1,480	2,974	10,061
Helena NF	212,790	331,489	415,182	---	203,659	27,427	25,736	158,360
Lewis & Clark NF	120,231	210,039	145,826	---	98,990	4,552	1,024	41,259
Lolo NF	90,711	189,569	28,869	---	8,509	720	3,704	15,936
TOTAL	**1,482,417**	**1,595,724**	**941,320**	**67**	**459,971**	**109,001**	**59,522**	**312,759**

* Area not surveyed in 1990.

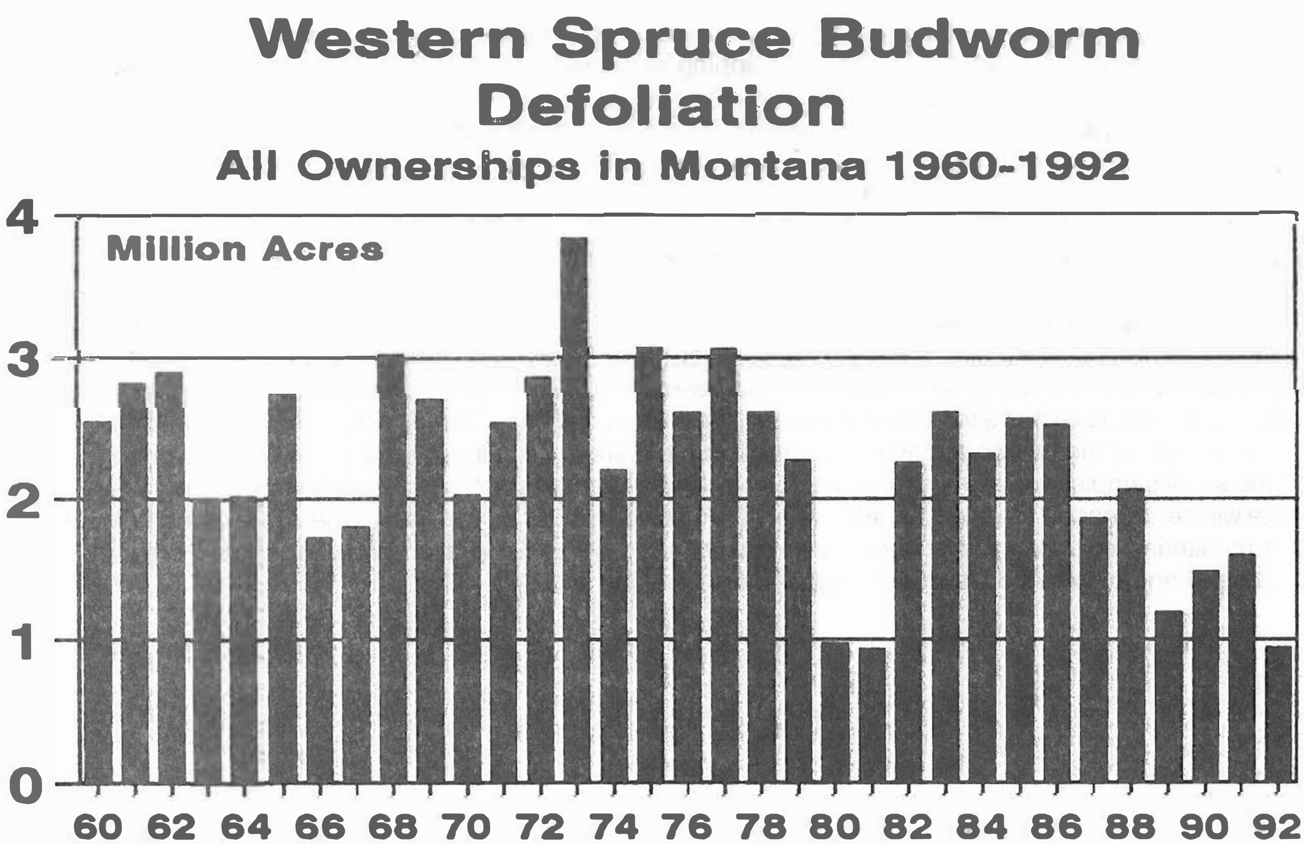


Figure 6--Western spruce budworm defoliation, 1960-1992

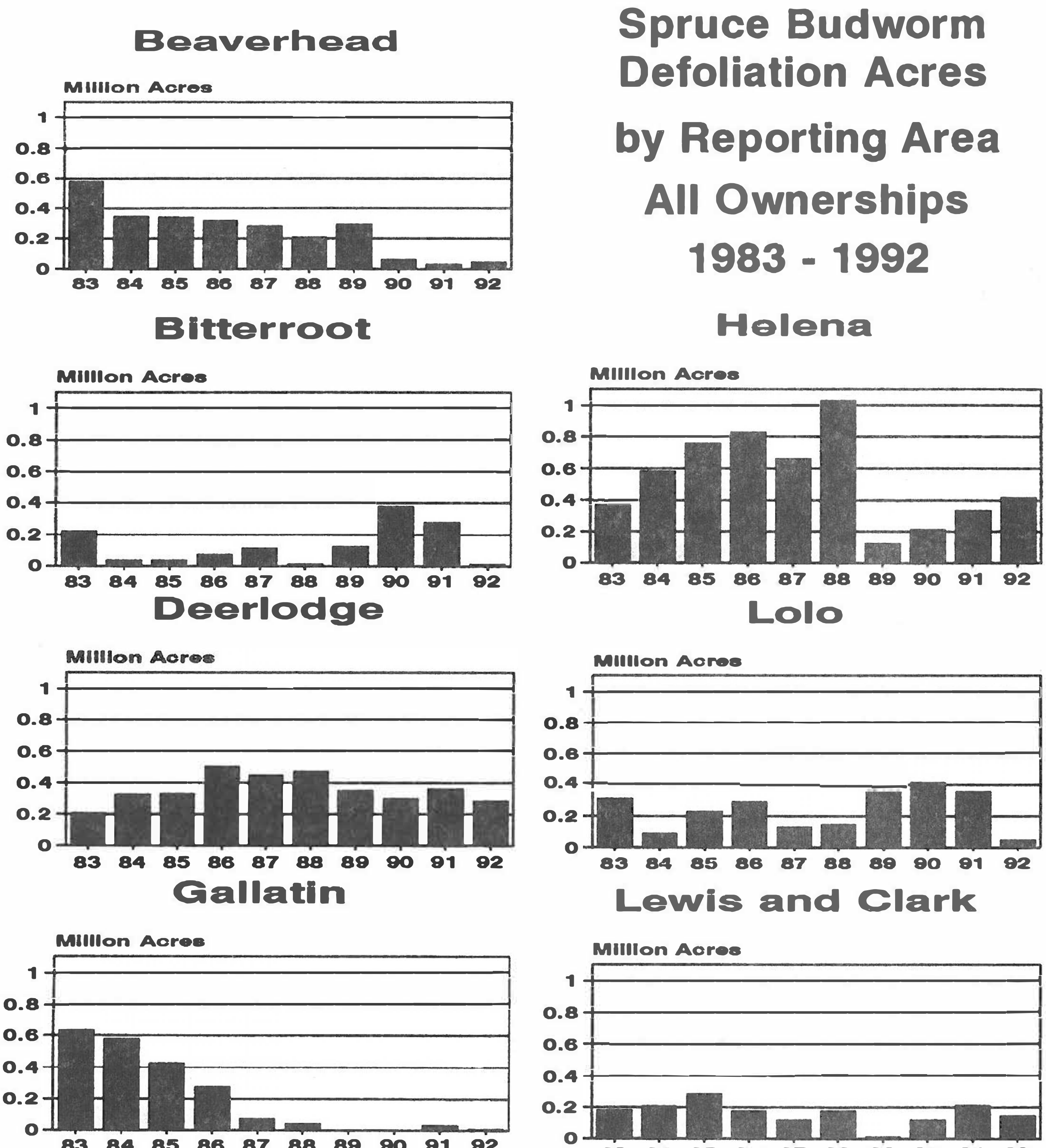


Figure 7--Spruce budworm defoliation by reporting area from 1983 to 1992

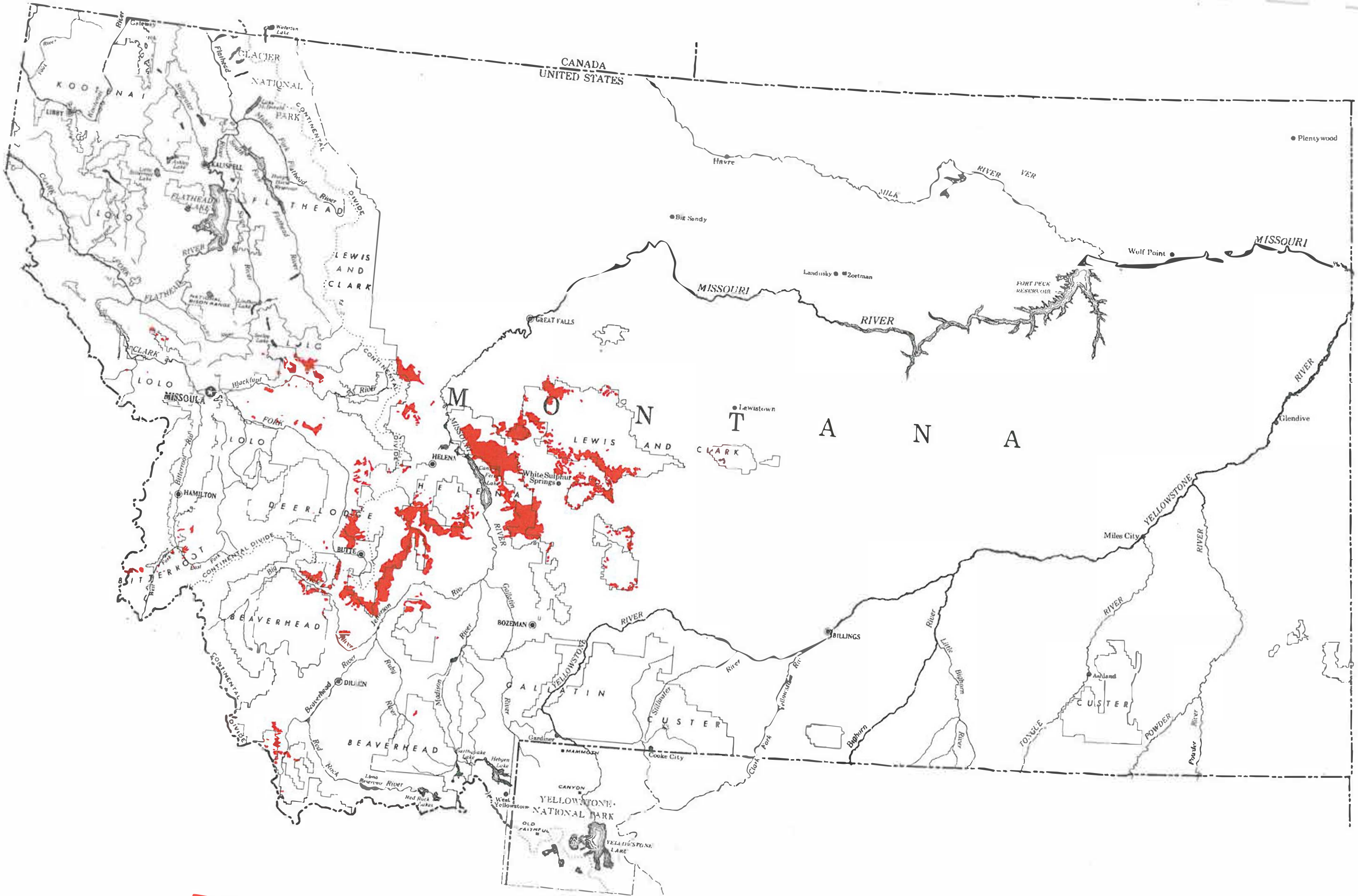


Figure 8--Western spruce budworm defoliation visible from the air in Montana, 1992.

Douglas-fir tussock moth

Pheromone-baited detection trap counts dropped from an average of 6.1 male moths per trap in 1991 to an average of 2.6 in 1992 (Figure 9). Defoliaton and egg masses detected on one tree near Big Fork. Only one site near Big Fork had a relatively high trap catch average, 29.0 male moths. No visible defoliation is expected in 1993.

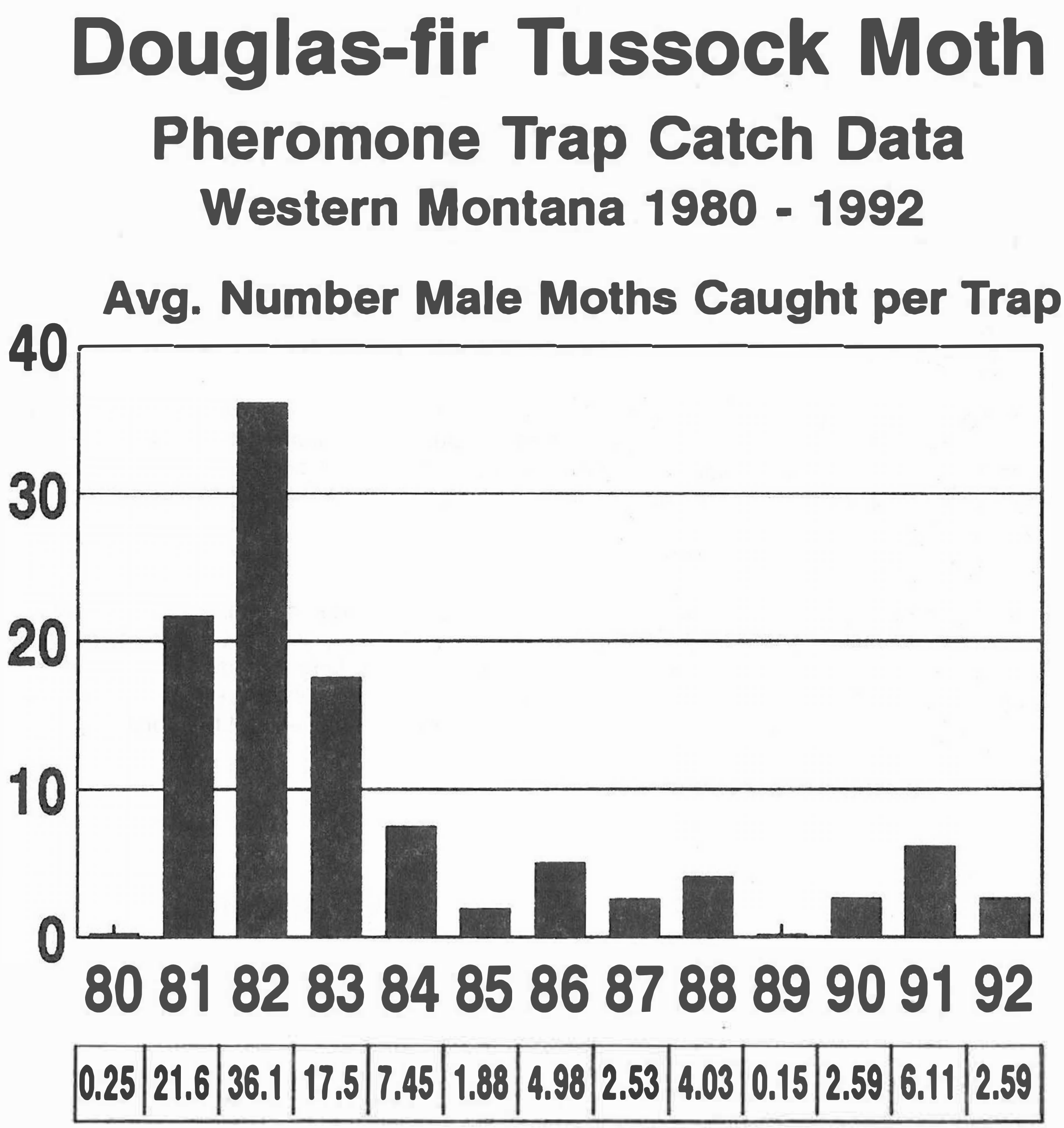


Figure 9--Douglas-fir tussock moth trap catch summary, 1980-1992

Gypsy moth (Lymantria dispar)

Early detection efforts for the European and Asian gypsy moth continued in 1992. A total of 1,500 pheromone traps were deployed throughout the state by the USDA Forest Service, Animal and Plant Health Inspection Service (APHIS), Montana Department of Agriculture, and Montana's state entomologist. One male European gypsy moth was caught in an APHIS trap in Liberty County near Chester, Montana. APHIS is planning to intensify trapping efforts near Chester in 1993 to determine if gypsy moths have become established and to define their range.

Tip moth (Rhyacionia species)

Identification efforts and impact studies on the tip moth species infesting ponderosa pine on the Crow and Northern Cheyenne IRs and Ashland, Sioux, and Medora RDs of the Custer NF continued in 1992. Three species of tip moth were positively identified: *R. fumosana, R. neomexicana*, and *R. bushnelli*. Either *R. zozana, R. buskana*, or both are also present. Greater than 99 percent of trees less than 3 meters in height showed signs of present and past tip moth feeding. More than 80 percent of tree whorls had fewer than three branches, more than 40 percent of the whorls were crooked, and 10 percent were forked. Tip moth damage leads to decreased growth rates and defect. Studies of management options to reduce tip moth impact will continue in 1993.

Sawflies (Neodiprion species)

Populations of *Neodiprion autumnalis* defoliated an estimated 1,989 acres on the Ashland RD of the Custer NF in 1992. Overwintering egg population surveys on the Ashland and Sioux RDs indicate that the potential for defoliation in 1993 is low.

Approximately 200 acres of limber pine were defoliated by an undetermined species of sawfly on private land south of Harlowton, Montana. The landowner sprayed the population, and no insects could be found in a post-spray survey. The sawfly population is not expected to cause substantial damage in 1993. Since no currently described species of sawfly feed on limber pine, this population may represent a new species.

Pine tussock moth (Dasychira plagiata)

A number of pine tussock moth larva were observed feeding upon ponderosa pine on the Ashland and Sioux RDs of the Custer NF in 1992. Aerial and ground surveys did not detect any associated defoliation. Pine tussock moth populations are known to suddenly errupt, then subside for a long period of time. When larvae are abundant, they can completely defoliate and and kill the trees. Pine tussock moth populations may erupt and defoliate ponderosa pine on the Custer NF in 1993. Forest Pest Management will be monitoring populations throughout 1993.

DISEASES

Dwarf Mistletoe Permanent Plots

Permanent plots were established around the Region during the summer of 1992. The main objective was to gather information on dwarf mistletoe spread and intensification, and dwarf mistletoe effects on tree growth. Data from the permanent plots will be used in the testing and validation of the Prognosis-linked dwarf mistletoe impact model and will also provide information on dwarf mistletoe effects on stand dynamics. Fourteen plots were established on seven different Ranger Districts on four different National Forests: Missoula and Superior RDs, Lolo NF; Bonners Ferry and Fernan RDs, Idaho Panhandle National Forests; Glacier View RD, Flathead NF; Libby RD, Kootenai NF; Wisdom RD, Beaverhead NF. The bulk of the plots were placed in stands infected with larch dwarf mistletoe. Two plots were established in stands infected only with lodgepole pine dwarf mistletoe, and two were placed in stands with a combination of larch and lodgepole pine dwarf mistletoe. Four different habitat type series are represented on the plots (grand fir, subalpine fir, Douglas-fir, western hemlock) with a total of 10 different habitat types. Plot elevations range from 3,600-7,100 feet and the average ages range from 25-150 years old. Baseline data analysis will be completed in 1993. Plots will be re-measured on a 5-year schedule.

Root Disease Permanent Plots

The eighth annual remeasurement of 218 permanent plots on Fernan RD, IPNFs, was marked in 1992. The plots are randomly placed in three compartments. The composition is primarily Douglas-fir and grand fir which regenerated following fires about 110 years ago. Mortality rates in trees greater than 5 inches d.b.h. have ranged from a low of 1.6 percent of trees in 1988, to a high of 6.4 percent in 1989.

The Douglas-fir component has been hardest hit with an average of 4.4 percent of trees >5 inches d.b.h. dying each year. The lowest rate for Douglas-fir was 1.7 percent. *Over the 8-year period, 30.4 percent of the Douglas-fir (>5 inches d.b.h.) have died on the plots*!

Other similar sets of permanent plots have been installed by Lochsa RD, Clearwater NF and Missoula RD, Lolo NF. Fernan RD has added a set in 40- to 80-age class, and Wallace RD, IPNFs and Stevensville and Darby RDs, Bitterroot NF, have installed plots to monitor results of group selection harvesting. Missoula RD added a fuel and decomposition transect to the plots last year.

COMPLETED PROJECT: ANNOSUS ROOT DISEASE

The Nez Perce NF annosus root disease study was reported on last year, but only part of the results were completed at that time. Three pairs of stands, each pair consisting of a 10- to 30-year-old clearcut and an adjacent uncut stand, in the grand fir habitat type series were examined intensively. The project has now been completed and here is a list of the most significant conclusions and results:

- Only the S type intersterility group of *Heterobasidion annosum* (causal agent of annosus root disease) is present in these stands.

- Spore infections are apparently the major means of introduction of annosus root disease into both the uncut and clearcut stands. Vegetative (root-to-root) spread is secondary in importance.

- Clearcutting significantly increased the frequency of *H. annosum* in these stands.

- Uncut stands in the grand fir habitat types in this area are infected with *H. annosum*, although at relatively low frequencies.

- Douglas-fir and grand fir have very similar disease incidence rates and are likely very similar in their susceptibility to infection by *H. annosum* in these stands.

- *H. annosum* is not the only root disease present in these grand fir habitat type stands. It is often found in combination with other root pathogens including *Armillaria* sp., *Phaeolus schweinitzii*, and *Perenniporia subacida*.

A complete report on the final conclusions and results will be published soon.

NEW PROJECT: PONDEROSA PINE DECLINE ON THE FLATHEAD INDIAN RESERVATION

Extensive root disease and/or drought symptoms and associated mortality of ponderosa pine have been occurring on the west side of the Flathead IR since the mid-1980's. Mature pines scattered throughout the forest have been dying at an unknown rate. Many crowns are thin, with needle retention lower than expected; terminal growth is poor; and in some cases, foliage color is chlorotic or appears to have a silver cast.

A project has been started to establish plots and monitor the decline of ponderosa pine on the Flathead Indian Reservation. Some questions we hope to answer with this project are:

- What are the causes of the decline and mortality?
- What is the rate of decline of individual trees?
- Are there predictable symptoms which can be related to time of mortality?

NURSERY - TREE IMPROVEMENT DISEASES

1992

New and Unusual Diseases

1. Leaf spot of chokecherry seedlings caused by *Septoria* sp. was confirmed for the first time on stock from the Bitterroot Native Growers Nursery in Hamilton.

2. *Melampsora occidentalis* was found on container-grown western larch germinants at the Raintree Nursery in Libby. This is the first record of this disease on stock being grown in nurseries in the Northern Region.

3. Several needle pathogens were identified on lodgepole and ponderosa pine trees at the Condon Tree Improvement Plantation (Swan Lake RD, Flathead NF). They included *Hendersonia pinicola*, *Lophodermella concolor*, and *Davisomycella montana* on lodgepole pine and *Gloeocoryneum cinereum* and *Pseudocenangium pinastri* on ponderosa pine.

4. Extensive freezing damage to bareroot Douglas-fir seedlings occurred during the spring at the Montana State Nursery in Missoula. Seedling buds had broken and new foliage was developing when unseasonably low temperatures occurred, causing extensive damage.

5. Freeze injury related to poor hardening during the fall was found on container-grown Douglas-fir seedlings at the Bitterroot Native Growers Nursery in Hamilton. Symptoms were similar to root disease and high levels of *Fusarium* spp. were consistently isolated from damaged seedlings. Seedlings were likely predisposed to root pathogens because of freeze injury.

6. Leafspot and chlorosis of elderberry (*Sambucus racemosa*) caused by *Ascochyta* sp. was detected on stock grown at the Glacier National Park Native Plants Nursery in West Glacier.

7. "Shot hole" of chokecherry (*Prunus virginiana*) seedlings was quite severe at the Montana State Nursery in Missoula. This disease is caused by the fungus *Phloeosporella padi* (=*Coccomyes hiemalis*).

8. *Cylindrocarpon* spp. were consistently associated with root disease of container-grown limber pine seedlings grown at the Bitterroot Native Growers Nursery in Hamilton. These fungi, although common on other five-needle pines, had not previously been reported on limber pine seedlings.

Common, Recurring Diseases

1. The most common and damaging diseases of conifer seedlings in nurseries in the Northern Region are caused by *Fusarium* spp. These pathogens occur at some level in all nurseries, although amount of damage may vary widely. Disease problems in bareroot nurseries are usually controlled by soil fumigation, which is effective in limiting disease severity. The most common soil-borne species in bareroot nurseries causing disease is *F. oxysporum*. Other *Fusarium* spp. may also occur, but are probably not as important as *F. oxysporum* in causing seedling disease. Disease in container nurseries is more difficult to control and epidemiology of the pathogens is different. The major pathogen in container nurseries is *F. proliferatum*; this species is especially prevalent on seedlings near the end of the growth cycle. All conifer species are susceptible, but most damage occurs on Douglas-fir, western larch, western white pine, and Engelmann spruce.

2. *Cylindrocarpon* spp. (especially *C. destructans*) continue to cause unacceptable losses to western white pine and whitebark pine seedlings at several nurseries. Although other conifer species are also affected, damage in the form of root decay is most extensive on five-needle pine.

3. *Botrytis cinerea* is a recurring problem in container-grown western larch and other conifer species. It may especially cause seedling deterioration during storage.

4. Tip dieback fungi such as *Sirococcus strobilinus*, *Sphaeropsis sapinea*, and *Phoma eupyrena* always occur at some level, particularly on bareroot pine seedlings.

5. *Pythium* root disease is most common in bareroot nurseries, but can also be found periodically in container operations.

Nursery Disease Projects

1. An evaluation of the efficacy of *Trichoderma harzianum* to control *Fusarium oxysporum* on container-grown Douglas-fir seedlings (in cooperation with the University of Idaho) was recently completed. Results of laboratory and greenhouse studies indicated that strains of *T. harzianum* tested were not effective in limiting root disease caused by *F. oxysporum*.

2. An evaluation of Mycostop biofungicide to control *Fusarium* root disease in container-grown Douglas-fir was recently completed (in cooperation with the University of Idaho). This biofungicide is a formulation of *Streptomyces griseoviridis* which is used as a seed dressing and applied topically. Data are currently being analyzed, but preliminary information indicates that this biocontrol agent may not be very effective in controlling *Fusarium* on Douglas-fir.

3. Investigations into the epidemiology of *Cylindrocarpon* spp. in greenhouses are continuing. Evaluations include characterizing species involved in disease, assessing pathogenicity, and formulating procedures to improve control. An evaluation to investigate fate of *Cylindrocarpon* spp. and their role in outplanting performance will be started this spring (in cooperation with the University of Idaho and Potlatch Corporation).

4. Investigations into the pathogenic potential of *Fusarium* spp. are continuing. Techniques have been developed to rapidly screen isolates for their potential as pathogens to conifer seedlings. These tests have thus far indicated that most isolates of *F. proliferatum* are much more aggressive than other species tested, including *F. oxysporum*. *Fusarium proliferatum* is well adapted to greenhouse environments, although the species is usually not a problem in bareroot nurseries. Efforts will continue to characterize the different fusaria associated with conifer seedling roots, including those that might potentially be used as biological control agents.

5. Fungus gnats have been found to vector several different types of fungi in greenhouse environments. Most were yeast-like organisms, including *Aureobasidium pullulans*. *Fusarium proliferatum* was also frequently isolated from the bodies of fungus gnats collected in greenhouses.

6. An evaluation to determine efficacy of different cropping regimes to control root diseases was initiated at the USDA Forest Service Nursery, Coeur d'Alene. This evaluation will test effects of cover crops, soil amendments and fallow treatments on fungal populations and resulting disease in bareroot seedlings. The project is being conducted with the Intermountain Research Station.

7. A multi-regional project to formulate alternatives to chemical soil fumigation for management of root diseases will commence in 1993. This project will entail trials at several nurseries in California, Oregon, Washington, and Idaho. The goals of the project are to develop alternative cropping regimes including soil amendments, cover crops, etc. and also develop procedures for differentiating pathogenic strains of *Fusarium oxysporum* collected from conifer nurseries. The project will include investigations by personnel from three Forest Service regions, several universities, private research laboratories, and state agencies.

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APPENDIX

COMMON AND SCIENTIFIC NAMES

Diseases

Common	Scientific	Host most affected
Annosus root disease	*Heterobasidion annosum* (Fr.) Bref.	DF, GF, PP, SAF
Armillaria root disease	*Armillaria ostoyae* (Romagn.) Herink	DF, GF, SAF
Atropellis canker	*Atropellis piniphila* (Weir) Lohm. and Cash	LPP
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.) Pat.	DF
Comandra rust	*Cronartium comandrae* Peck.	LPP, PP
Diplodia blight	*Sphaeropsis sapinea* (Fr.) Dyko.	PP
Dutch elm disease	*Ceratocystis ulmi* (Buism.)	Dutch Elm
Dwarf mistletoes	*Arceuthobium* spp.	Most conifers except TF, WH, W, MH
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker	PP
Fusarium root rot	*Fusarium oxysporum* Schlect.	DF (Nursery)
Grey mold	*Botrytis cinerea* Pers. ex Fr.	WL (Nursery)
Larch needle blight	*Hypodermella laricis* Tub.	WL
Larch needle cast	*Meria laricis* Vuill.	WL
Laminated root rot	*Phellinus weirii* (Murr.) Gilb.	DF,GF, WH, SAF
Lodgepole pine needle cast	*Lophodermella concolor* (Dear.) Dark.	LPP
Pini rot	*Phellinus pini* (Thore:Fr.) Pilet.	DF, WL, ES, All pines
Sirococcus tip blight	*Sirococcus strobilinus* Preuss	WWP (Nursery)
Swiss needle cast	*Phaeoeryptopus gaeumannii* (Rohde)	DF
Western gall rust	*Endocronartium harknessii* (Moore) Hirat.	LPP, PP
White pine blister rust	*Cronartium ribicola* Fisch.	WWP, WBP

Insects

Common	Scientific	Host most affected
Douglas-fir beetle	*Dendroctonus pseudotsugae* Hopkins	DF
Douglas-fir tussock moth	*Orygia pseudotsugata* (McDunnough)	DF, TF, ES
Gypsy moth	*Lymantria dispar* (Linnaeus)	Most hardwoods
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins	All pines
Pine engraver beetle	*Ips pini* (Say)	PP, LPP
Spruce beetle	*Dendroctonus rufipennis* (Kirby)	ES
Western balsam bark beetle	*Dryocoetes confusus* Swaine	SAF
Western spruce budworm	*Choristoneura occidentalis* Freeman	DF, TF, ES, WL
Western pine beetle	*Dendroctonus brevicomis* LeConte	PP
Fir engraver beetle	*Scolytus ventralis* LeConte	GF, SAF
Lodgepole terminal weevil	*Pissodes terminalis* Hopping	LPP
Balsam Woolly Adelgid	*Adelges piceae* (Ratzeburg)	SAF, GF

DF = Douglas-fir; GF - Grand fir; TF = True fir; SAF = Subalpine fir; PP = Ponderosa pine; LPP = Lodgepole pine; WWP = Western white pine; ES = Engelmann spruce; WH = Western hemlock; WL = Western larch; MH = Most hardwoods; WRC = Western redcedar

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